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# Turning Plantations into Healthy, Fire Resistant Forests

## Outlook for the Granite Burn

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The 17,000-acre Granite Fire of 1973 completely consumed most of the vegetation within its perimeter. The intent of replanting the Granite Burn mostly with pines and leaving some areas unplanted for deer habitat was to return the area as quickly as possible to productive forest land with high wildlife and watershed values. Now, this 24-year old restoration effort is at a critical phase. The area is now a complex of mostly dense pine plantations intermixed with unplanted patches of thick brush, mostly white thorn. Fuels are heavy and continuous despite some efforts at thinning and limbing plantation trees. Unless something is done to reduce the fire hazard, the odds are high that another stand-replacing fire will sweep the area during the next half century, negating an investment of decades of time and thousands of dollars in re-establishing timber, wildlife, watershed and recreational values. The situation calls for quick action now, to buy two or three years to develop and begin implementing a feasible, long-range plan.



A reasonable approach to fire planning for the Granite Burn area includes two phases:

1. Develop through expert consultation a list of actions that will immediately reduce the unacceptably high fire risk while maintaining management options for the future; and
2. Develop a landscape fire-modeling framework to evaluate the costs and benefits of longer-term management options.

A short reconnaissance in September 1997 by Clay Brandow and Dave Sapsis of FRAP in the Granite Burn area raised five key questions.

1. Does the Granite Burn area, with its considerable investments in plantations and other assets at risk, run a considerable risk of another stand replacing fire?
  - Yes, many of the plantation-brush complexes have high fuel loading. Few plantations have been thinned. In many places fuels are dense, continuous and most of the young trees have fuel ladders from the ground to their growing tips.

Ironically much of current predicament derives from the great success in getting trees to grow back quickly after the Granite Burn. Rehabilitation projects did not need to plant trees so densely in most places or in such large, contiguous stands. Aggressive efforts to grow an extensive mature forest as quickly as possible nearly guarantees that a mature forest will not re-establish without significant human intervention, controlling the threats of pests and fire.

2. What actions have been or could be proposed to mitigate that risk?

- Based on phone interviews with the Groveland Ranger District's fire and timber management officers, thinning and limbing have been proposed. Some thinning and limbing has been done on the public land, but more timber stand improvement has been done on the private land. Prescribed and fuel breaks have been proposed by the District. Reducing the amount of white thorn and planting some of these areas to trees in the "Deer Retention Areas" on national forest lands is under consideration. Most of these areas are no longer needed for transitional deer habitat.

3. Are any of these actions congruent with timber production and sustained high-value wildlife habitat?

- Yes, some of these actions improve timber stands, some of them improve wildlife habitat, and some actions do both. While timber production and high wildlife value are often not congruent, another extensive, stand-replacing fire would make both unattainable for another 60 to 80 years or more. Some combination of the proposed techniques, arranged across the landscape in an appropriate sequence, will considerably reduce the risk of such an event.

These treatments are likely to be expensive. Public safety will not justify the large expense, because the Granite Burn is so far removed from areas of human settlement. Timber production alone may not justify the investment because the long investment period (treatment time to harvest time). Long-term timber production and immediate harvest of some smaller commercial timber, combined with wildlife habitat restoration and watershed protection, could justify the investment. Any new investments contemplated making would be small compared to the time and money already invested in the Granite Burn since the fire in 1973.

However, there is one important caveat. As mentioned above, at least one technically feasible and affordable solution exists, and that through analysis a means can be found to reduce the risk of an extensive, stand-replacing re-burn to an acceptable level. In the unlikely event that a solution cannot be identified, further investments in the Granite Burn would need to be considered.

In many respects the situation in the Granite Burn is similar to many other re-vegetated areas in high-risk, high-hazard fire areas. While many aspects of the

problem are well documented, there are few if any examples where learning through implementation, or adaptive management, is underway.

4. Does it matter where on the landscape, in what ownership and in what order these actions occur?

- The answer to this question is not known at this time, but it is an important question to analyze. Objectives on the public and adjacent private lands are likely to be different. However, in order for private and public land management within the Granite Burn to be successful, the whole landscape will need to be analyzed. The resulting recommended actions could require mutual accommodation by public and private land managers.

For example, if the private land is managed intensively for timber and the surrounding public land is managed less intensively for timber and more for a wildlife friendly objective like mixed age stands, this might help the private "island" of intense silviculture survive to maturity. On the other hand, if both the public and private lands are managed intensively for timber, the risk of a stand replacing fire consuming the entire area prior to commercial harvest may be increased.

5. What approach to an initial environmental analysis to inform project implementation would be appropriate?

- A reasonable approach to planning management of the Granite Burn area includes two phases:

Phase 1: develop, through expert consultation, a list of actions that will immediately reduce the unacceptably high fire risk while maintaining management options for the future. Phase 1 is important because a stand-replacing fire due to inaction in the near term would be a major error. On the other hand, taking any ill-considered actions that might cut off future management options should be avoided. If a more varied approach was taken after the 1973 fire, the present watershed, wildlife, and timber predicament might have been avoided to some degree. Regardless of past decisions, the Granite Burn now represents an investment of nearly a quarter century and millions of public and private dollars. California cannot afford to lose this large forest area while considering the next round of actions. Activities prescribed in phase 1 might include typical pre-fire, pre-attack work, such as reducing fuels along roads and around campgrounds, and pre-need construction of some strategically placed fire lines and water-chances.

Phase 2: develop a landscape fire-modeling framework to evaluate the costs and benefits of long- term management options. Phase 2 is important because the investment of time and money is so large. Selecting objectives and designing a strategy that has a high likelihood of meeting timber, wildlife, and watershed

objective, a fire-modeling goal would be to find workable scenarios to meet chosen objectives at acceptable costs and with acceptable risk. If this scenario cannot be developed, objectives should be modified and the prospective feasibility of fire models applied.

The following field observations, photos, and comments of FRAP's fuel and fire behavior consultant, Dave Sapsis, provide detailed information on the status of the fuels in the Granite Burn area.

## **Granite Burn Area Field Visit**

### *Background*

In 1973, the Granite Fire burned through 17,000 acres of what was a checkerboard ownership involving USDA Forest Service and private timberlands on the eastern portion of the Groveland Ranger Unit of the Stanislaus National Forest (Figure 1). Sierra Pacific Industries currently owns much of the southern fire area – a result of a land transfer consolidation that happened after the fire. The vegetation was typical mixed conifer, of which the majority was killed by fire. Although the species composition prior to the fire was undoubtedly mixed because of site and stand history factors, market considerations lead owners to replant the area primarily as pure ponderosa pine.

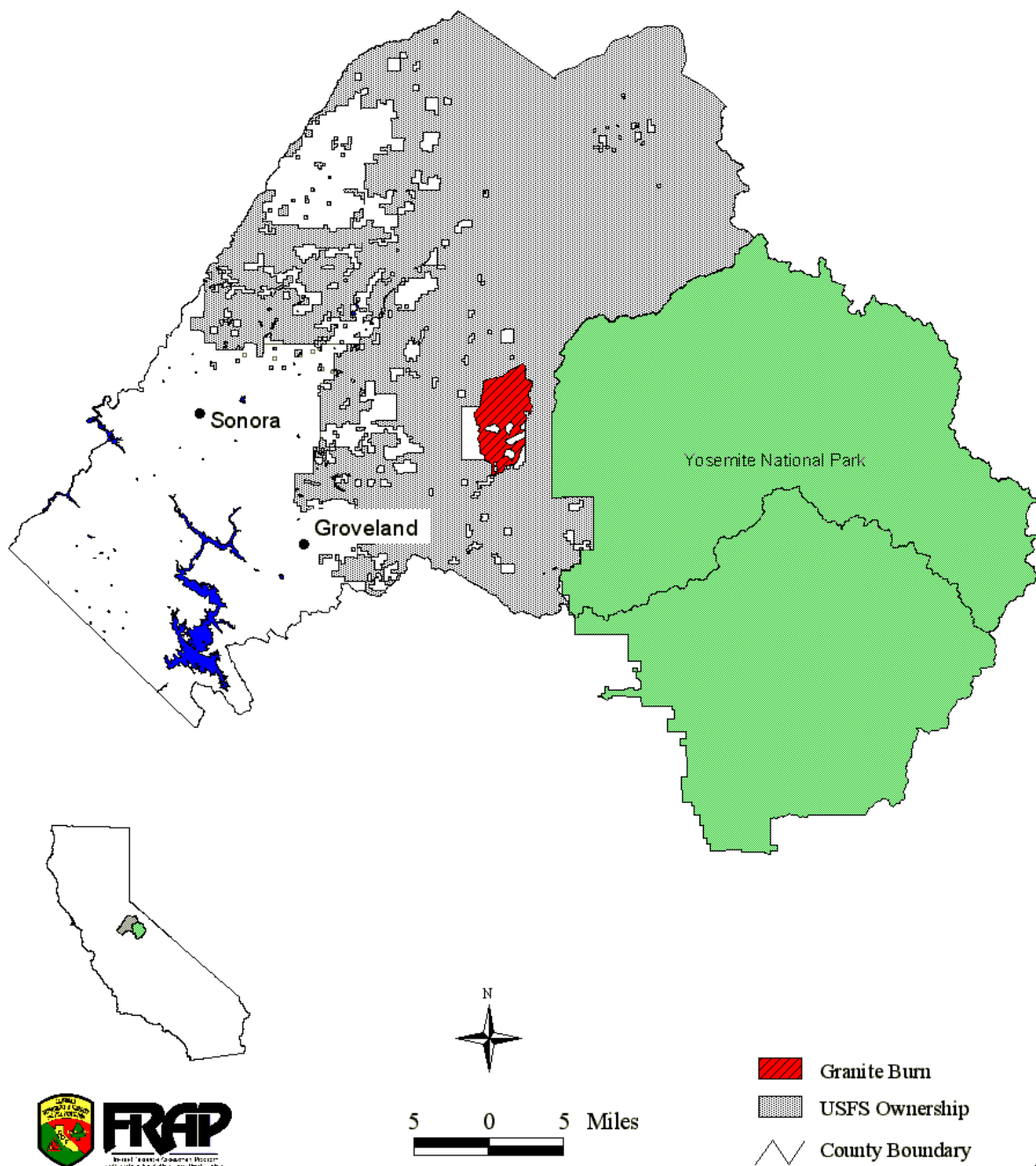


Figure 1. Granite Burn

### Summary

The Granite Burn Area requires management to promote forest health and resilience to adverse fire impacts. Both fire and competitive stress threaten the development of the plantations into mature forest ecosystems.

Fuels in the fire area range from isolated areas of low hazard to extensive areas of high hazard where brush and young trees form continuous live fuels capable of carrying crown fire. Some of the plantations have established and grown sufficiently such that they would likely carry a surface fire. Such areas, however, may exhibit significant mortality, even when under burned within a prescription that would consume most of the forest floor. The mosaic of fuel and site conditions, given the coincidence of an ignition with severe fire weather, will likely result in a large, stand-replacing fire similar to the 1973 event.

Plantations with high survival and establishment are currently overstocked and should be thinned to reduce competitive stress and potential insect damage. In some areas, the over story density of pole sized trees compounds the hazard by providing a uniform high-density canopy fuel complex that could not only carry crown fire, but would also trap convective heat and increase crown scorch and mortality.

Finally, erosion has undermined infrastructure critical to fire suppression. Road washouts slow initial attack, and would delay extended attack containment.

Effective fire management strategies should be designed to both limit potential wildfire size, and reduce adverse impacts on areas that do burn. The status quo (no action) is unacceptable, since the likely result is a repeat of the devastation of 1973.

Stand-based prescriptions in conjunction with a watershed/landscape planning effort can reduce potential fire size. Landscape management with Defensible Fuel Profile Zones (DFPZs - linear fuel reduction areas associated with ridges and roads varying from 100 to 1500 ft in width) can block off areas and limit wildfire spread. While not designed to preclude long range spotting, this strategy breaks up fuel continuity and will increase suppression capabilities as well as stand resilience in the treated areas. Site specific stand improvements and fuel modifications can increase stand resilience should that area be subjected to wildfire. Individual prescriptions need to be based on site/stand conditions, as discussed below, where multiple benefits across hazard, timber, wildlife, and watershed issues can be collectively addressed.

Timing and location of treatments could have a profound impact on resources, but without a landscape, multi-year analytical framework it is impossible to gauge these impacts. The spatial considerations and ownership patterns indicate cooperative projects would be necessary for maximum hazard reduction. Hence, both near-term expert assessment, and long-range analytical planning should engage both public and private concerns for creating a healthy and resilient forest in the Granite Fire area.

### *Fuels*

Forest fuels consist of three discrete strata, or layers, that define the vertical fuel structure:

- Surface fuels - plant litter/duff, dead and downed woody material, and small live materials in close proximity to the ground. By convention, this stratum may extend a maximum of six feet above the ground but usually less than two feet.
- Crown fuels - crowns of the dominant trees on the site.
- Ladder fuels - live and dead plant materials that link the surface fuel stratum to the crown fuel stratum. Understory shrubs, attached dead stems on dominant and suppressed trees, and canopies of small understory trees form the majority of ladder fuels.

Conditions in each of these strata influence prescriptions designed to reduce risk, hazard, and potential damage arising from fire, insects, or other disturbance.

#### *Fire behavior and relationship to effects*

Surface fire drives most other aspects of fire behavior in California. When the stratum blur together, the entire vertical structure behaves like a surface fuel complex. When fires crown (i.e., spread through the canopy), they depend on heat flux from combustion of the surface fuel stratum. This active (or dependent) crown fire differs from two other types of crown fire: (1) passive, where individual or groups of trees torch but do not spread to adjacent canopies, and (2) independent crown fire, where fire propagates in the tree crowns with no connection to surface fire. Passive crown fire is extremely common in California where fine scale fuel conditions (e.g. surface "jackpots" under low reaching tree canopies) promote torching. Active crown fire is much less common, but can occur under the right combination of fuel, site, and environmental conditions. The sustained spread of active crown fire requires a continuous horizontal and vertical fuel complex where surface fuel and crown characteristics all meet threshold levels. Independent crown fire is virtually absent from the California landscape indicating that canopy density changes independent of any surface fuel treatments are pointless.

The relationship between fire behavior characteristics and effects on trees is not linear. Sometimes surface fires result in significant mortality and other times not. Surface fire can kill root, cambial and foliar tissues, all of which can contribute to direct and indirect mortality. Often, surface fires stress trees and allow other disturbance agents such as insects to increase their activity. Usually, as trees torch and most of their canopy is consumed, the tree will die. Crown fire is almost always associated with full mortality of the stand.

#### *Observations*

- A large, high-severity fire could easily reoccur in the Granite Burn area. The overall continuity of surface fuels, the juxtaposition of different fuel types, and the extensive ladder fuels in many of the successfully established plantations create fuel conditions that support large severe fires. With the largely south facing aspect, mixed topography, and typical fire weather regimes of the Tuolumne River area, a large, severe fire is likely over a 50 year horizon if fuel conditions are not managed.
- Fuel conditions vary considerably from area to area. Stands of similar fuel conditions vary in size from a few acres to patches approaching 500 acres.

- Much of the area has continuous surface fuels of whitethorn manzanita with a high live fuel component creating a relatively low risk (ignition probability) but a high hazard (potential fire behavior) situation.
- Replanted areas vary in tree density and surface fuel characteristics. Some areas have isolated tree establishment in brush fields. Others have appropriate stocking density for successful forest development with significant brush in the interspaces. While still others display significant overstocking with limited surface litter fuels, isolated ladder fuel conditions, and very high crown densities.
- Some areas that were under burned or unburned enclaves during the Granite Fire have well developed surface and ladder fuel conditions likely to support torching of mature residual trees if burned under severe fire weather.
- Forest managers are treating some stands, mostly adjacent to the primary road network. Limbing (pruning branchwood from below) and thinning in conjunction with brush and slash piling seem to be the main tactics to treat these areas.
- Significant channeling and erosion in isolated areas has undermined the road network. From a fire protection standpoint, as well as an ecological indicator, these conditions exacerbate risk (increasing the likelihood of ignitions from cars, as they have to leave the roadbed to turn around) and potential fire size.

#### *Individual Stand Descriptions and Discussion*

Specific stand descriptions and photos document both the generally uniform and extensive hazard in the fire area and the differences relevant to a strategy to mitigate the hazard.

This analysis focused on the USDA Forest Service lands on the northern portion of the fire area, but in traveling the major roads it became apparent that pre-commercial thinning is ongoing on private ground. Most of the area has been planted to ponderosa pine at varying densities. All plantations with successful establishment have small trees (2-9" dbh) at very high densities. Some of the roadside areas are thick with trees at roughly 8-10 foot spacing, subject to pre-commercial thinning (photo 1).



Thinning and leaving in place is evident, as well as thinning and piling presumably with the intent of burning. There is a striking mix of understory fuels throughout the area, probably indicative of different site prep and brush control measures interacting with soil conditions. Some areas of solid regeneration (over 90 percent) had interspaces of grass and forbs (photo 2) while others had shrub presence sufficient to create a live fuel continuum in both horizontal and vertical dimensions. The nature of the roadside treatment appears to be a combination of stand improvement and DFPZ/fuel break strategy (photo 3).





The national forest contains areas that were not planted, the so-called "deer-release" areas (photo 4). Because of the land exchange, some deer-release areas may now be held in private ownership. A flight or access to SPI's stand records could verify this. These areas are classic fuel model 5 - medium-high brush with almost no standing dead or litter component. This fuel system being relatively low in hazard through much of the fire season can manifest severe fire behavior (running through the live crowns, short range spotting into adjacent plantations and mature forests).



Poor establishment of conifers on some national forest land has led to a mixture of brush and trees (photos 5, 6). Stand density runs the gamut from less than 10 percent canopy to upwards of 60 percent, which probably represents the upper limit of density for successful future intermediate/mature stands prior to a commercial thin. These stands will burn in a manner similar to the brush fields shown in photo 4 but are difficult to treat for fuels without damage to the residual trees. The best option is probably to leave these areas alone. As the established trees mature, they will eventually out-compete the brush. Other issues relating to problems with excessive stand density do not apply here.





Some national forest land is characterized by solid tree establishment with brush in the interspaces (photo 7). These areas generally demonstrate poorer growth (due to competition or poor site) and appear to be on more xeric ground than comparable areas with similar tree density but greater growth and less brush. The high tree density requires treatment including stand thinning and brush control. These types of stands might be viewed as archetypical for the area: fuel and stem density requiring stand improvement and hazard reduction to ensure future forest development. Uniform fuels in the horizontal and vertical dimensions will support a fire that propagates through the live crowns of the brush and pole sized trees resulting in high levels of mortality and other adverse impacts associated with high intensity wildfire.



Isolated areas on the national forest were planted to mixed species, including white fir, Douglas fir, and giant sequoia (photo 8). Although these were only seen in one area, presumably there are more of these mixed plantations. Overall, this stand represented a low density version of the "successful plantation with interspersed brush" type, possibly owing to lower planting density and more active site prep. Most of this area had not only less brush cover than the average for pure pine plantations, but the shrubs also seemed shorter in stature. Significant wind, low humidity, and low live fuel moistures would be required for successful fire spread in this stand. Areas such as these should constitute a lower priority for treatment due to the more discontinuous nature of the fuel bed.



Some stands have high levels of tree establishment with canopy characteristics forming a continuous aerial fuel complex that extends from the surface to the tops of the trees (photo 9). These stands can be thought of as analogous to the pure brush systems from a fuel standpoint in that understory fire is unlikely. While there is only moderate litter component at the surface, the vertical continuity of the crowns allows no separation for a surface fire and passive/active crown fire will result. These stands are in need of thinning and removal/treatment of the slash to increase forest health and fire resistance.



Finally, areas of extremely good pure pine establishment and excellent growth have created stands as above but with a distinct separation of the surface litter fuels and the canopy. These plantations have touching canopies and limited forest floor fuels. Most of these areas have surface fuels consisting of only small twigs and needle litter (photo 10) thus emulating an FBPS model 9. Other areas have individual or small clumps of brush amongst the forest litter. In general, trees in these stands had the greatest growth rates with leaders showing approximately two feet per annum growth. Given the spacing, the trees will likely soon shut down both leader and radial increment due to competition. Although surface fuel conditions do not constitute a particular hazard from a fire suppression point-of-view, the well developed duff layer could present a threat to the stand should it be entirely consumed by a fire (either wildfire or prescribed).



The most pressing issues regarding these stands center on their impending shut down (i.e., precipitous reduction in growth that can sometimes be irreversible) and increased susceptibility to beetle infestation. However, these stands are limited in extent and usually lie next to areas of significantly greater fuel hazards such as the open brush/failed plantation areas. If weather supported a moving fire in these open brushy areas, fire could enter these fully stocked plantations and continue as an active (running) crown fire. Both from a stand improvement-ecology-habitat standpoint and from a stand resilience, crown fire potential standpoint the stands need thinning and slash treatment.

#### *General Discussion*

Plantations represent the greatest investment from a timber production standpoint. Commercial thinning probably would not yield revenue sufficient to pay for the slash treatment required to assure stand resilience. Understory prescribed fire may be effective by emulating thinning while also reducing the surface and limited ladder fuels

and contributing to break up the stands' homogeneity. However, early entry with prescribed fire requires careful development of prescriptions and has met with limited success in similar areas.

From a landscape perspective, it is likely that SPI has many of the same issues on areas under its management. Given the site quality of the land, the transportation network, and proximity to mills it is unlikely many acres of privately held land escaped attempts at planting. Thus, it appears likely that SPI has many of the same plantation concerns regarding the feasibility of taking these stands to harvest and are actively seeking options for increasing that likelihood.

Pre-commercial thinning that simply cuts the trees and leaves them in place reduces stem density but increases the fuel hazard. Thus, the basic problem for the well-established plantations is designing a cost effective treatment plan. Silviculturalists from both the federal and private side are concerned about how to handle well-growing plantations of this age. Mike Landram, R5 Regional Silviculturist, defined three pressing problems driving a need for action:

- Where the pine plantations have taken, independent of fuel concerns, the stands are overstocked.
- Competition and beetles, in addition to the creation of continuous crown fuels, constitute considerable threats to the development of these plantations. High tree density tends to increase tree damage through increased crown scorch resulting from limiting the escape of the convective heat rising from the surface fire.
- The USDA Forest Service does not have a sufficient Timber Stand Improvement budget to do much about it. Landram estimates that at least 300,000 acres within Region 5 need treatment. Many of the private plantations are in a similar situation, and contribute to the landscape level problem.

### *Summary*

- Fuel conditions show relatively good correlation with site prep effectiveness and sapling establishment.
- These conditions vary across a wide range throughout the burn area.
- Issues of fuel condition (hazard) are confounded with stand structure and resilience.
- DFPZs can be used to break up continuity of fuels, thereby limiting potential fire size.
- Treatments need to be assigned on a stand by stand basis.
- There appears little opportunity to implement stand improvement without incurring costs.
- Pre-commercial thinning without removal exacerbates hazard/threat to residual stand.
- DFPZ types of strategies used alone do little to improve stand conditions in untreated areas.

Issues relating to developing both a quick and an extended framework for analysis of fuel management options:

- No framework exists currently to assess tradeoffs between treatment costs and the expected reduction in wildfire and/or beetle damage.
- Managers appear to be taking a "wait and see" attitude toward the shut down issue. If stands make it another five years or so, a commercial thin might offer the potential for combined stand improvement/hazard reduction with little cost.
- The relationship between canopy structure and crown fire potential in California mixed conifer systems is poorly understood. Ongoing attempts to quantify and map crown fire potential will also offer inference in regard to stand resilience and treatment. The Interagency Fuel Mapping Group (CAIFMG) has a subcommittee working on this issue in conjunction with the Intermountain Fire Sciences Laboratory. Additionally, FRAP is working on formulating a forest assessment project that ties silviculture to fire hazard and effects.
- Finally, an analysis providing effective solutions requires data that are not available currently. That is, there is no way to create an effective program of stand improvement and hazard reduction in this burn area without maps of what has been done and what is out there. If an analytical approach is desired, these data will have to be developed. Again, the CAIFMG is working toward that end and a proposed mapping project for this area is in the works.